A Study of the First Global Measurements of the Water Cycle

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Project hypothesis: Natural climatic variations and human activities drive water mass exchanges among Earth's ocean, ice, land, and atmosphere components on monthly time scales that are detectable using GRACE

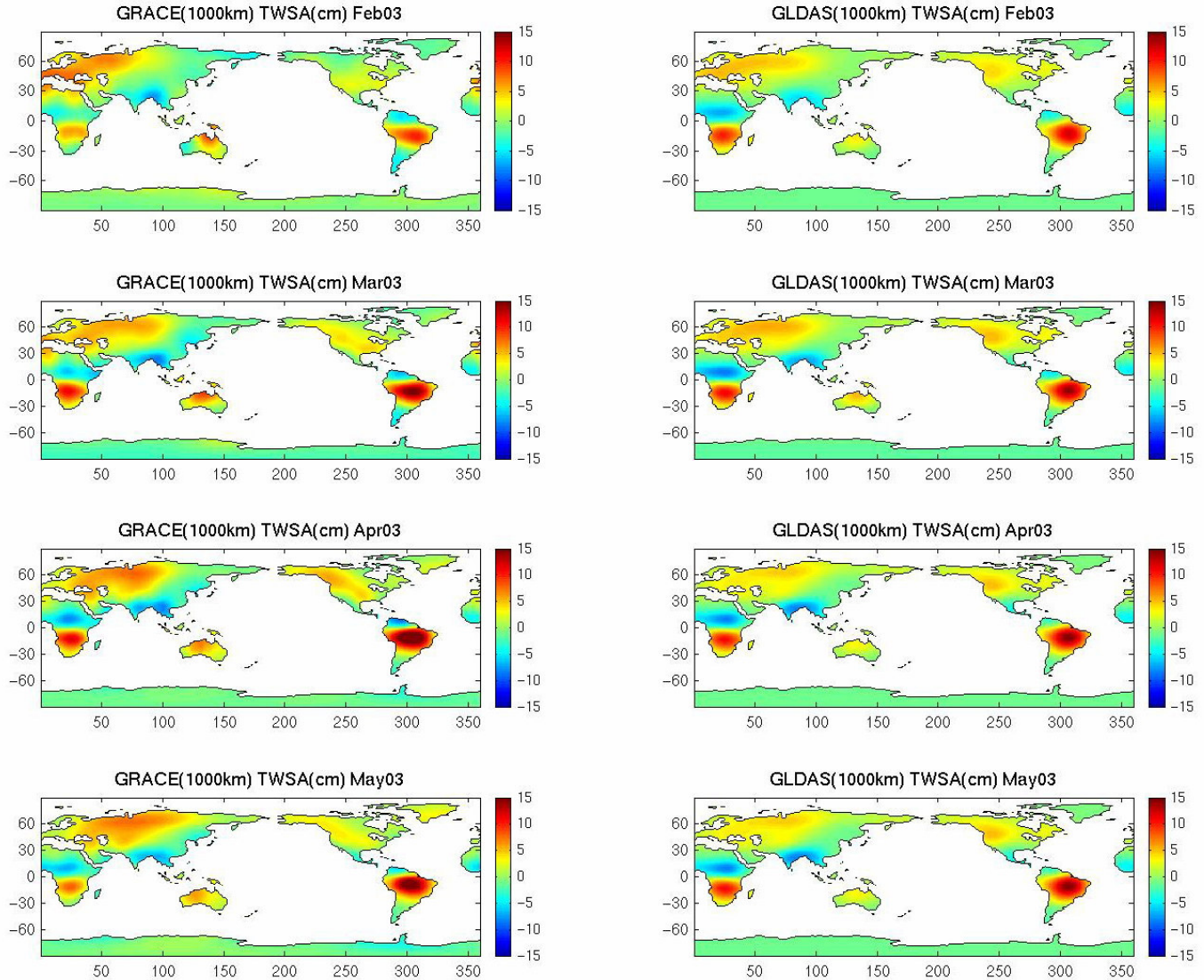
Objectives & deliverables:

- Use GRACE observations of time-variable gravity in conjunction with other sensors and data sets, to provide a first global, comprehensive assessment of monthly water storage changes in Earth's ocean, ice, land and atmosphere reservoirs
- Characterize the range of flux estimates of precipitation and evaporation between the storage reservoirs from the NEWS team and from observation-assimilating numerical weather prediction models like ECMWF, and to determine their consistency with the GRACE-derived storage changes

- Use the spatial patterns of water storage change to characterize water mass redistribution, including source and sink regions

Technical approach and/or methods:

- Estimate storage changes for land (total land area, continents, drainage regions) using GRACE
- Estimate monthly variations of the ice mass from the Greenland and Antarctic ice sheets and major Alpine glaciers using GRACE, ICESat and GPS
- Esimate ocean mass changes using GRACE with constraints from TOPEX/Jason
- Estimate global atmospheric water mass variations from NEWS team and from ECMWF and other NWP models
- Produce monthly time series of global water balance (storage changes) for GRACE period of available GRACE data
- Explore whether P - E flux estimates from NEWS, NWP and NASA models are consistent with land, ocean, atmosphere and ice storage changes
- Establish connection between regional sea level rise and water sources on land
- Fingerprinting method for signatures of interannual variability and climate change



Famiglietti et al., 2005, in review

NASA ENERGY AND WATER CYCLE STUDY

NEWS

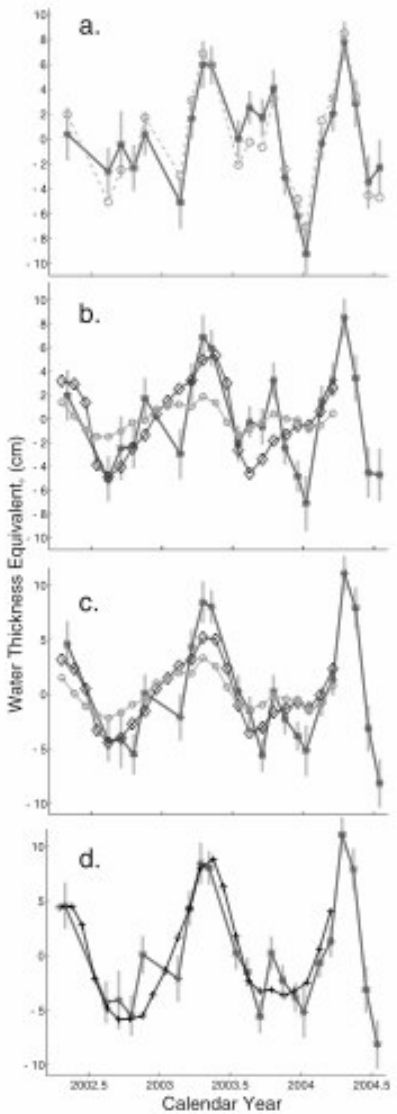
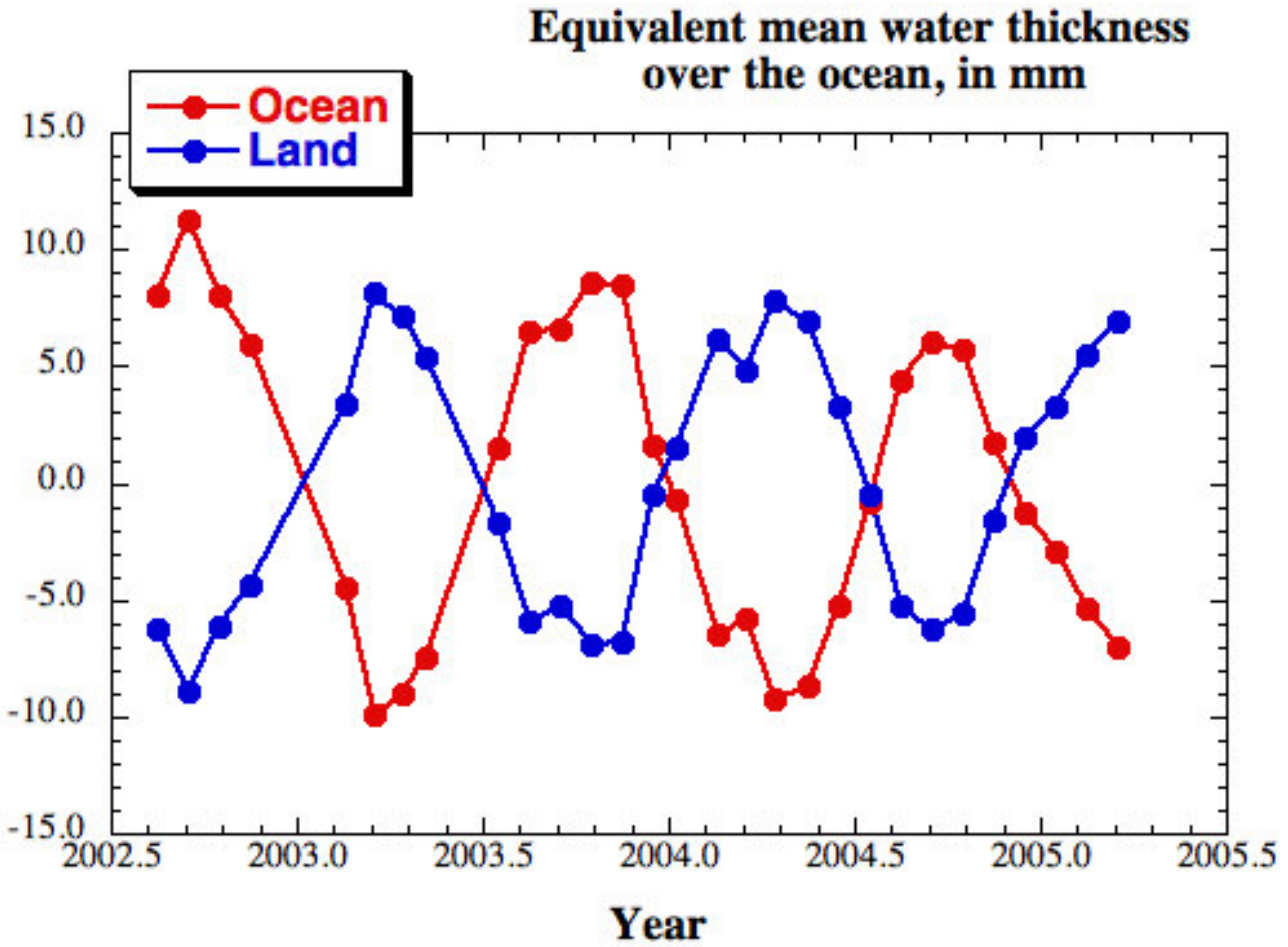


Figure 1. (a) Nonsecular Greenland mass variability from the GRACE (stars). Error bars come from convolving our averaging function with estimates of the gravity coefficient uncertainties. Also shown (circles) are the GRACE results

Velicogna and Wahr, 2005



GRACE measures average water mass changes

- Accuracy of ~ 2-3 mm of equivalent water thickness for large regions (global-scale)
- There is a seasonal exchange of water mass between land and ocean
- By studying averages over continents and drainage basins, we expect to quantify major sources of exchange
- Interannual variations (e.g., ENSO) currently unknown; GRACE will measure as well

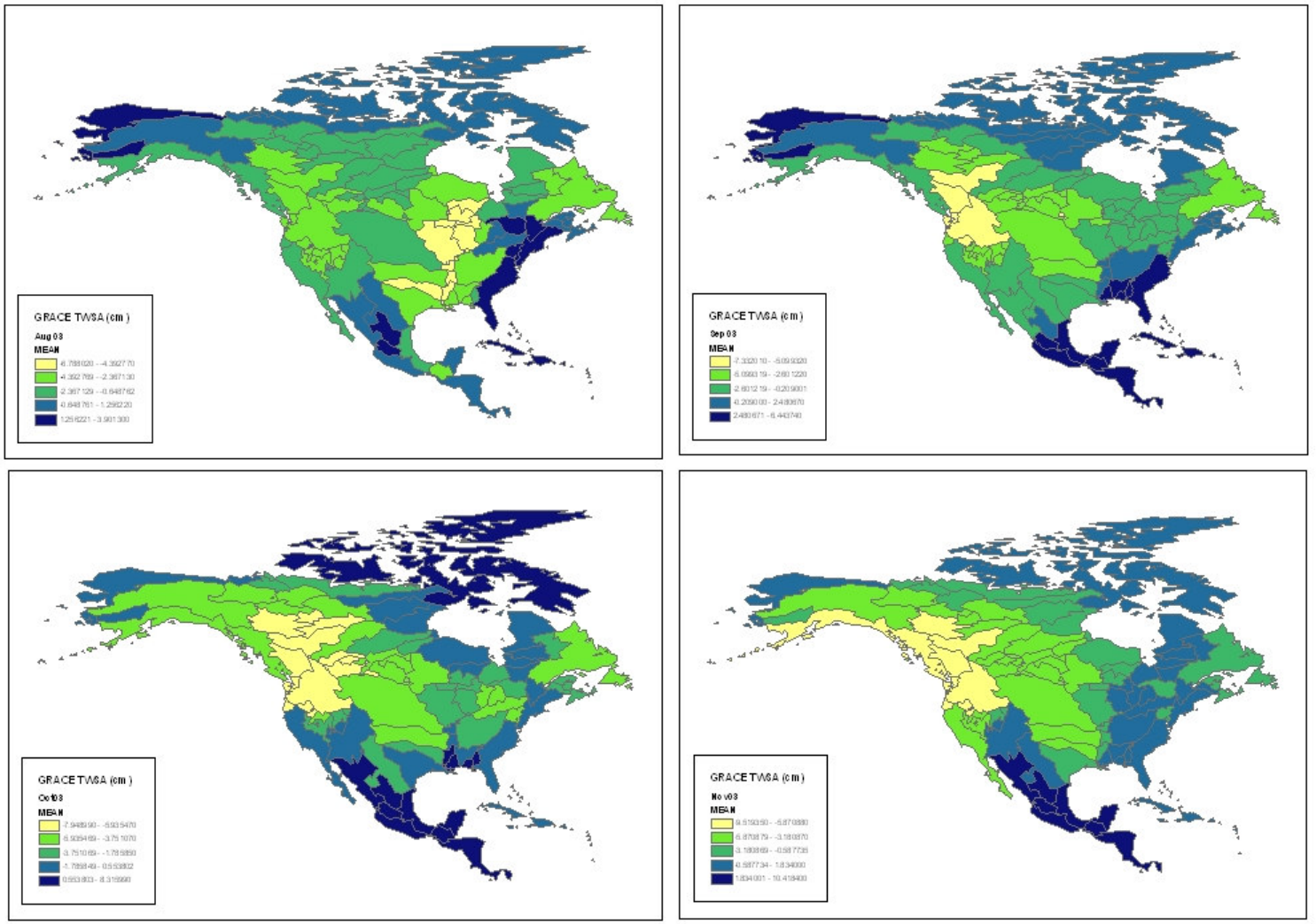
Data set needs:

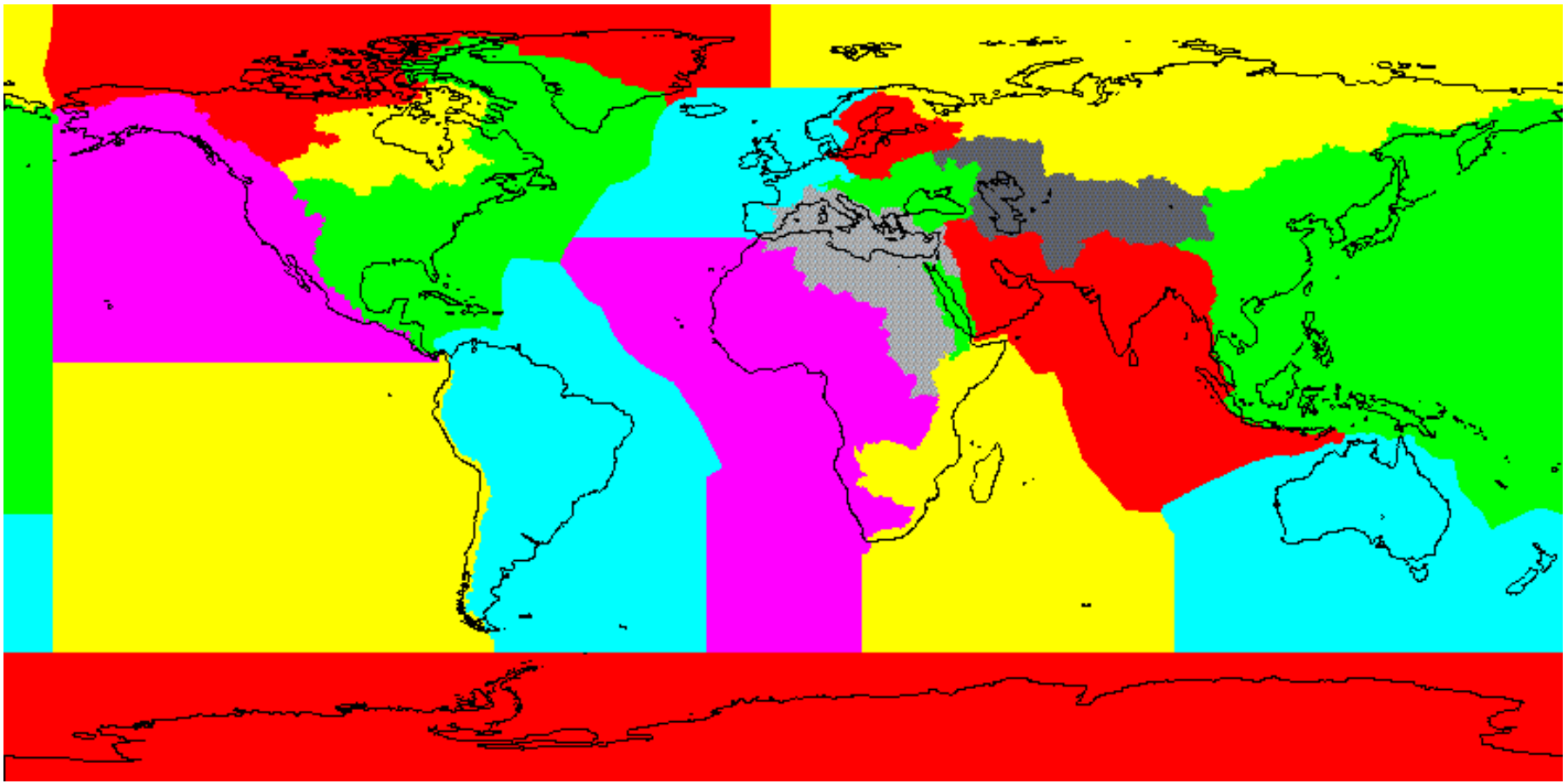
- GRACE time-variable gravity coefficients
- ICESat elevations for ice sheets
- NEWS, NCEP, ECMWF atmospheric pressure data, precipitable water data, global P, E, terrestrial runoff
- GLDAS land models water storage and fluxes
- AMSR soil moisture

Project outputs:

- Monthly estimates of water mass changes for land, ocean, atmosphere and ice
- GRACE land water storage change estimates for regions of interest to NEWS team
- Regional estimates of sea level rise

GRACE (600 km) TWSA over Level 2 Basins in North America





Nineteen terrestrial drainage regions and the ocean basins to which they deliver fresh water. From Graham et al. [1999]

Potential collaborations (with NSIT, other NEWS projects, etc.) **:**

- Roads
- Rodell
- Reichle
- Koster
- Adler
- Curry
- Olson
- Liu
- Wentz

Important outside linkages/resources (outside the NEWS team) **:**

- GRACE science team
- ECMWF/NCEP
- CUAHSI
- GEWEX

Expected contribution to the NEWS objective:

- Characterize mass variations in global water cycle
- Characterize role of GRACE as a component of a global water cycle monitoring system
- Constrain flux estimates from NEWS effort and from NWP and NASA global models
- Contribute products for data assimilation

Issues, needs, and concerns (to be discussed in breakouts, teaming discussions, etc.)**:**

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